Observations of atmospheric greenhouse gases with a Fourier transform spectrometer onboard GOSAT (Greenhouse Gases Observing SATellite)

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The Greenhouse gases Observing SATellite (GOSAT), launched on 23 January 2009, is the world's first satellite dedicated to measuring the concentrations of the two major greenhouse gases, carbon dioxide (CO_2) and methane (CH_4), from space. The data observed with the Thermal And Near-infrared Sensor for carbon Observation - Fourier Transform Spectrometer (TANSO-FTS) and the Cloud and Aerosol Imager (TANSO-CAI) are processed into several types of data products. Column-averaged volume mixing ratios of CO_2 and CH_4 (XCO_2 and XCH_4), Level 2 FTS SWIR (Short-Wavelength InfraRed) data product, are retrieved from the Level 1B FTS SWIR spectral data. Validation of the GOSAT TANSO-FTS SWIR Level 2 products is critical since the data are used for generating the Level 3 FTS product, global distributions of XCO_2 and XCH_4 statisticaly interpolated and averaged on a 2.5 x 2.5 deg. grid, and the Level 4 product, regional CO_2 fluxes and three dimensional distribution of CO_2 calculated from the estimated fluxes. Yokota et al. [1] reported the first preliminary result observed with GOSAT TANSO-FTS SWIR.

Preliminary validation of the GOSAT TANSO-FTS SWIR Level 2 products was made with ground-based high-resolution FTS data of the Total Carbon Column Observing Network (TCCON) [2]. XCO_2 and XCH_4 retrieved with the TANSO-FTS SWIR ver. 01.xx retrieval algorithm showed large negative biases and standard deviations (-8.85 ppm and 4.75 ppm for XCO_2 and -20.4 ppb and 18.9 ppb for XCH_4, respectively) compared with the TCCON data [3].

Therefore we investigated the influence of aerosols and thin cirrus clouds on XCO_2 by lidar and sky radiometer at Tsukuba TCCON site (36.051N, 140.122E), and found that it was important to take into account vertical profiles of aerosols and thin cirrus clouds and to use more adequate solar irradiance database in order to improve the GOSAT XCO_2 data [4]. Based on these results and sensitivity analysis of the retrieval algorithm, multiple reasons for these error characteristics (e.g., solar irradiance database, handling of aerosol scattering) are identified and corrected in a revised version of the TANSO-FTS SWIR retrieval algorithm (ver. 02.xx). The improved retrieval algorithm showed much smaller biases and standard deviations (-1.48 ppm and 2.09 ppm for XCO_2 and -5.9 ppb and 12.6 ppb for XCH_4, respectively) than those of the ver. 01.xx. [5].

To improve further the retrieval algorithm, we have started to investigate the impact of aerosols and thin cirrus clouds on the GOSAT data over Moshiri (44.366N, 142.261E), Tsukuba and Saga (33.241N, 130.288E) in Japan, and Lauder (45.038S, 169.684E) in New Zealand by high-resolution ground-based FTS, lidar and sky radiometer. Also we are attempting an empirical correction of TANSO-FTS SWIR Level 2 products by using the simultaneously retrieved auxiliary parameters to suppress remaining temporal and spatial dependencies in biases. We found higher correlations between the corrected GOSAT and TCCON data after the empirical correction.

We will present the latest results on the GOSAT observations, activities of validating the GOSAT TANSO-FTS SWIR Level 2 products with TCCON and aircraft data, and improving the retrieval algorithm.

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